unknown, or mistaken; and the relationship, by structure or by imitation, of the species and varieties is dwelt upon. For the description of the better-known Foraminifera, the memoir refers to the works of Williamson and Carpenter.

The authors enumerate 109 specific and varietal forms, most of which receive descriptive comment, and all of which are figured in five plates (two for the North Atlantic and three for the Arctic Foraminifera) with upwards of 340 figures.

The relationships of the *Lagenæ* are specially treated of. *Uvigerina, Globigerina,* and especially some of the *Rotalinæ* (*Planorbulina, Discorbina, Rotalia, Pulvinulina*) and *Polystomella* (including *Nonionina*) are among those which are well represented in the fauna under description, and have received much attention in the memoir.

The Society then adjourned over the Whitsuntide Recess to Thursday, May 26.

May 26, 1864.

Major-General SABINE, President, in the Chair.

The following communications were read :—

I. "Note on the Variations of Density produced by Heat in Mineral Substances." By Dr. T. L. PHIPSON, F.C.S., &c. Communicated by Professor TYNDALL. Received April 16, 1864.

That any mineral substance, whether crystallized or not, should *diminish* in density by the action of heat might be looked upon as a natural consequence of dilatation being produced in every case and becoming permanent. Such diminution of density occurs with idocrase, Labradorite, felspar, quartz, amphibole, pyroxene, peridote, Samarskite, porcelain, and glass. But Gadolinite, zircons, and yellow obsidians *augment* in density from the same cause. This again may be explained by assuming that under the influence of a powerful heat these substances undergo some permanent molecular change. But in this Note I have to show that this molecular change is *not permanent* but intermittent, at least as regards the species I have examined, and probably with all the others. Such researches, while tending to elucidate certain points of chemical geology, may likewise add something to our present knowledge of the modes of action of heat.

My experiments were undertaken to prove an interesting fact announced formerly by Magnus, namely, that specimens of idocrase after fusion had diminished considerably in density without undergoing any change of composition: before fusion their specific gravity ranged from 3·349 to 3·45, and after fusion only 2·93 to 2·945. Having lately received specimens of this and other minerals brought from Vesuvius in January last by my friend Henry Rutter, Esq., I determined upon repeating this experiment of

Magnus. I found, *first*, that what he stated for idocrase and for a specimen of reddish-brown garnet was also the case with the whole family of garnets as well as the minerals of the idocrase group; *secondly*, that it is not necessary to *melt* the minerals: it is sufficient that they should be heated to redness without fusion, in order to occasion this change of density; *thirdly*, that the diminished density thus produced by the action of a red heat is not a permanent state, but that the specimens, in the course of a month or less, resume their original specific gravities.

These curious results were first obtained by me with a species of lime garnet, in small yellowish crystals, exceedingly brilliant and resinous, almost granular, fusing *with difficulty* to a *black* enamel, accompanied with very little leucite and traces of grossular, and crystallized in the second system.

Specimens weighing some grammes had their specific gravity taken with great care, and by the method described by me in the 'Chemical News' for 1862. They were then perfectly dried and exposed for about a quarter of an hour to a bright red heat. When the whole substance of the specimen was observed to have attained this temperature, without trace of fusion, it was allowed to cool, and when it had arrived at the temperature of the atmosphere, its specific gravity was again taken by the same method as before. The diminution of density being noted, the specimens were carefully dried, enveloped in several folds of filtering paper, and put aside in a box along with other minerals. In the course of a month it occurred to me that it would be interesting to take the specific gravity again, in order to ascertain whether it had not returned to its original figure, when, to my surprise, I found that each specimen had effectively increased in density and had attained its former specific gravity. Thus:—

Lime garnet (*from Vesuvius*).

Original density.	Density after being heated red-hot for a quarter of an hour and allowed to cool.	Density determined in a month after the experiments.
I. 3·345	2·978	3·344
II. 3·350	2·980	3·350
III. 3·349	2·977	3·345

The same experiments were made with several other minerals belonging to the idocrase and garnet family, and always with similar results. Now I ask, what becomes of the heat that seems to be thus shut up in a mineral substance for the space of a month? The substance of the mineral is dilated, the distance between its molecules is enlarged, but these molecules slowly approach each other again, and in the course of some weeks resume their original positions. What induces the change? or how does it happen that the original specific gravity is not acquired immediately the substance has cooled?* Will the same phenomenon show itself with other families of minerals or with the metallic elements?

Some minerals like euclase, that become *electric* by heat, retain that state for a

Such are the points which I propose to examine in the next place; in the mean time the observations I have just alluded to are a proof that bodies can absorb a certain amount of heat not indicated by the thermometer (which becomes *latent*), and that this is effected *without the body undergoing a change of state*; secondly, that they slowly part with this heat again until they have acquired their original densities; thirdly, so many different substances being affected by a change of density when melted or simply heated to redness and allowed to cool, it is probable this property will be found to belong, more or less, to all substances without exception.

II. "On the Spectra of some of the Fixed Stars." By W. Huggins, F.R.A.S., and William A. Miller, M.D., LL.D., Treasurer & V.P.R.S., Professor of Chemistry, King's College, London. Received April 28, 1864.

(Abstract.)

After a few introductory remarks, the authors describe the apparatus which they employ, and their general method of observing the spectra of the fixed stars and planets. The spectroscope contrived for these inquiries was attached to the eye end of a refracting telescope of 10 feet focal length, with an 8-inch achromatic object-glass, the whole mounted equatorially and carried by a clock-movement. In the construction of the spectroscope, a plano-convex cylindrical lens, of 14 inches focal length, was employed to convert the image of the star into a narrow line of light, which was made to fall upon a very fine slit, behind which was placed an achromatic collimating lens. The dispersing portion of the arrangement consisted of two dense flint-glass prisms; and the spectrum was viewed through a small achromatic telescope with a magnifying power of between 5 and 6 diameters. Angular measures of the different parts of the spectrum were obtained by means of a micrometric screw, by which the position of the small telescope was regulated. A reflecting prism was placed over one half of the slit of the spectroscope, and by means of a mirror, suitably adjusted, the spectra of comparison were viewed simultaneously with the stellar spectra. This light was usually obtained from the induction spark taken between electrodes of different metals. The dispersive power of the apparatus was sufficient to enable the observer to see the line *Ni* of Kirchhoff between the two solar lines D; and the three constituents of the magnesium group at *b* are divided still more evidently *. Minute

considerable time. The *increase* of density of Gadolinite and the *decrease* of density of Samarskite by the action of heat are accompanied by a vivid emission of light, as mentioned in my work on 'Phosphorescence' &c., pp. 31 and 32, where H. Rose's ingenious experiment is described.

* Each unit of the scale adopted was about equal to $\frac{1}{1800}$th of the distance between A and H in the solar spectrum. The measures on different occasions of the same line rarely differed by one of these units, and were often identical.